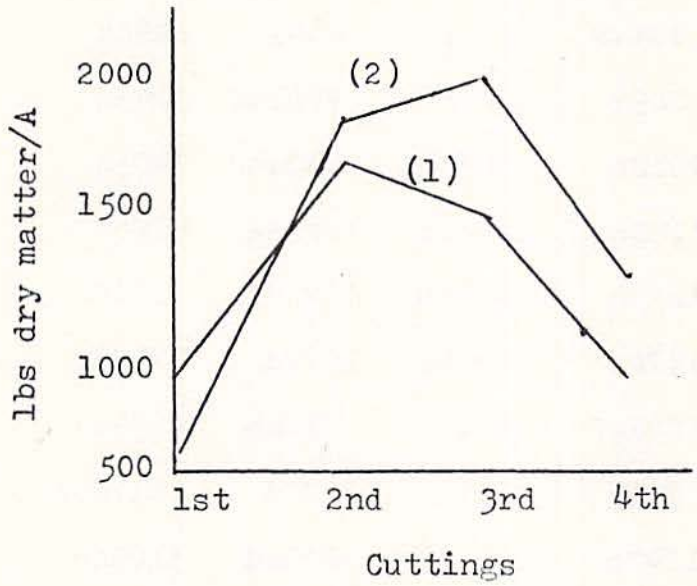
Figure 1. The relationship between time of nitrogen application and dry matter yield of grassland under pasture management. Gully, Minnesota - 1974.



(1) 200 lbs N/A applied in early spring

(2) 200 lbs N/A in four applications, 50 lbs in early spring plus 50 lbs after the 1st, 2nd, and 3rd cuttings

Hay yields on the first cutting, Table 3, were drastically increased by early spring applications of nitrogen. On the second cutting, no response was recorded due to nitrogen, in addition to basic phosphorus and potassium applications, probably due to the increased rate of mineralization during mid-summer.

Table 3. Dry matter yields for grassland under hay management (2 cuttings) for various dates of harvest and nitrogen fertilization treatments. Gully, Minnesota - 1974.

Treatments lbs/A			Grass Production lbs dry matter/acre		
N	P_2O_5	K_2O	June 19	Sept 3	Total
0	0	0	1243a+	2387a	3630a
0	100	300	1399ab	3529cde	4928bc
100	0	0	1580abc	2805ab	4385ab
50	100	300	1939bcd	3371abc	5310cd
100	100	300	2445de	2987cde	5432cd
150	100	300	2671ef	3529de	6200def
200	100	300	2754ef	3789de	6544efg
* 50	100	300	2002cd	3993de	5995def
*100	100	300	2350de	3801e	6151def
*150	100	300	2794ef	4072e	6866fg
*200	100	300	3144f	4027de	7171g
Significance			**	**	**
BLSD (.05)			545	632	923

+ Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

* Plots received an additional 50 lbs N/A following the first cutting.

The protein levels for both pasture and hay management (Table 4) were excellent. In both cases protein levels were not greatly increased, however, total nitrogen uptake per acre was greatly increased (Table 5).

Table 4. Protein levels for grassland under pasture and hay management for various dates of harvest and nitrogen fertilizer treatments. Gully, Minnesota - 1974.

Treatments lbs/A			Percent Protein					
			pasture				hay	
N	P_2O_5	K_2O	May 29	June 19	July 21	Sept 3	June 19	Sept 3
0	0	0	22.9ab+	17.0ab	18.3	17.6abcd	11.8	11.4
0	100	300	22.3a	16.3a	18.0	16.5a	12.3	10.0
100	0	0	24.6bc	17.5ab	19.1	18.2cde	12.3	12.3
50	100	300	24.5bc	16.9ab	18.4	17.2abc	11.6	11.2
100	100	300	24.2abc	16.8ab	17.6	17.5abcd	12.2	11.8
150	100	300	24.2abc	16.0a	17.9	16.9ab	12.7	11.0
200	100	300	27.9d	17.9ab	18.7	17.9bcd	13.3	11.3
* 50	100	300	22.9ab	16.1a	17.6	17.8bcd	11.6	10.0
*100	100	300	23.9abc	15.8a	17.3	18.3cde	12.2	10.0
*150	100	300	25.8c	16.6ab	18.0	18.4de	12.7	10.2
*200	100	300	25.5c	17.4ab	17.0	18.3de	13.3	9.5
** 50	100	300	23.1ab	18.7b	17.8	19.2e	--	--
Significance			**	*	NS	**	NS	NS
BLSD (.05)			2.0	2.1		1.1		

+ Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

* Plots received an additional 50 lbs. N/A following the second cutting (pasture management) and following the first cutting (hay management).

**Plots received an additional 50 lbs. N/A following the first, second, and third cutting (pasture management).

Table 5. Nitrogen removal by grassland under pasture and hay management for various dates of harvest and nitrogen fertilizer treatments. Gully, Minnesota - 1974.

Treatments lbs/A			Grass production - lbs. dry matter/acre							
			pasture					hay		
N	P_2O_5	K_2O	May 29	June 19	July 21	Sept 3	Total	July 19	Sept 3	Total
0	0	0	15a+	24ab	27a	21a	87a	25a	45	70a
0	100	300	12a	21a	29ab	26abc	88a	30a	51	81bc
100	0	0	23abc	28bc	28a	26abc	105ab	26a	47	73ab
50	100	300	25abcd	32cd	38bc	28bc	123bc	29a	57	86cd
100	100	300	30bcd	34cd	31ab	30cd	124bc	42b	49	91de
150	100	300	37de	38de	35ab	29bc	139cde	48b	58	106fg
200	100	300	44d	49f	44cd	23ab	160ef	48b	61	109g
* 50	100	300	20ab	26ab	56e	32cd	133cd	29a	64	93de
*100	100	300	35cde	32c	53de	31cd	150def	42b	56	98ef
*150	100	300	37de	42e	57e	29bc	164f	48b	64	112g
*200	100	300	36cde	43ef	52de	29bc	160ef	48b	59	107fg
** 50	100	300	20ab	55g	57e	36d	167f	---	--	---
Significance			**	**	**	**	**	**	NS	**
BLSD (.05)			13	6	9	6	22	10		9

\+ Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

* Plots received an additional 50 lbs. N/A following the second cutting (pasture management) and following the first cutting (hay management).

** Plots received an additional 50 lbs. N/A following the first, second, and third cutting (pasture management).

PHOSPHORUS TRIAL

Six phosphorus treatments arranged in a randomized complete block design were replicated four times. The phosphorus trial, located adjacent to the nitrogen trial, was conducted under the same type of management and experimental conditions as previously outlined. In addition to the phosphorus treatments, 150 lbs. nitrogen per acre was applied in split applications on all but the check treatment, 100 lbs. N/A was applied in the early spring with an additional 50 lbs. N/A following the first cutting under hay management, and after the second cutting for pasture management. Besides the basic nitrogen treatment, 300 lbs. K_2O/A was broadcast in early spring to all but the check plots.

In 1974, the dry matter yields were significantly increased in three out of four pasture clippings and in both of the hay management cuttings (Table 6). Under pasture management 100 lbs. P_2O_5/A, in combination with nitrogen and potassium applications gave the optimum yield increase of 1480 lbs. D.M/A, when compared to applications of nitrogen and potassium without phosphorus. On the fourth pasture clipping, nitrogen and potassium applications with no applied phosphorus resulted in a significant decrease in yield, probably due to a nutrient imbalance causing tissue phosphorus levels to fall below the critical level. Under hay management 50 lbs. P_2O_5/A gave the optimum results with a yield increase of 781 lbs. D.M/A.

Table 7 includes the whole plant analysis for the four pasture clippings. Phosphorus percentages in the tissue were significantly increased in all but the second cutting. The total phosphorus removed under pasture management (Table 8) ranged from 10.8 to 28.3 pounds phosphorus per acre. The phosphorus recovery percentage ranged from 32 percent at the 50 lbs. P_2O_5/A rate to 19 percent at the 200 lbs. P_2O_5/A rate.

Soil samples were taken on October 24 at various depths to determine whether any phosphorus movement through the profile had occurred. The results shown in Table 9 indicate large differences in phosphorus concentrations were present due to phosphorus applications and clearly illustrates that the major percentage of applied phosphorus remained in the top 3 inches of the soil profile.

Table 6. Dry matter yields for grassland under pasture and hay management for various dates of harvest and phosphorus fertilizer treatments. Gully, Minnesota - 1974.

Treatments lbs/A			Grass production - lbs. dry matter/acre				
			pasture				
N	P_2O_5	K_2O	May 29	June 19	July 21	Sept 3	Total
0	0	0	371a+	863a	1249a	1045b	3528a
150	50	300	737bc	1275c	2274c	976b	5262c
150	100	300	909c	1320c	2320c	959b	5508cd
150	150	300	924c	1366c	2408c	1020b	5718d
150	200	300	1021c	1372c	2427c	993b	5813d
150	0	300	604ab	1078b	1623b	723a	4028b
Significance			**	**	**	**	**
BLSD (.05)			291	194	197	215	395
			hay				
0	0	0		1345a		3178a	4523a
150	50	300		2405bc		4208bc	6613bc
150	100	300		2231bc		4333bc	6564bc
150	150	300		2512bc		4445bc	6957c
150	200	300		2697c		4355c	7052c
150	0	300		2049b		3846b	5895b
Significance				**		**	**
BLSD (.05)				530		500	794

+ Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

Table 7. Plant analysis for grassland under pasture management for various dates of harvest and phosphorus fertilizer treatments. Gully, Minnesota - 1974.

Treatments lbs/A			%				ppm					
			P	K	Ca	Mg	Al	Fe	Zn	Cu	Mn	B
N	P_2O_5	K_2O				First Cutting - May 29						
0	0	0	0.40b+	2.99a	0.42	0.15	30	105	34.1	0.9	33.0	6.4b
150	50	300	0.41b	3.84b	0.38	0.14	21	100	33.3	1.3	30.9	5.9ab
150	100	300	0.53c	4.11b	0.41	0.14	13	107	34.4	0.4	33.5	5.3a
150	150	300	0.58cd	3.96b	0.40	0.14	8	93	33.1	0.7	31.1	5.1a
150	200	300	0.63d	3.81b	0.42	0.15	19	107	32.5	1.0	34.3	5.9ab
150	0	300	0.31a	3.81b	0.37	0.13	30	107	34.9	1.3	30.4	5.8ab
Significance			**	**	*	*	NS	NS	NS	NS	NS	*
BLSD (.05)			0.08	0.45	0.03	0.02						0.8
						Second Cutting - June 19						
0	0	0	0.42	3.53	0.59	0.19	44	131b	30.5	1.4	40.9	7.1
150	50	300	0.40	3.72	0.39	0.14	49	113ab	25.8	1.3	33.1	6.1
150	100	300	0.38	3.69	0.39	0.14	24	110a	25.8	0.0	32.1	6.0
150	150	300	0.45	3.54	0.41	0.14	25	98a	23.4	1.7	33.8	5.2
150	200	300	0.50	3.73	0.44	0.15	28	93a	23.7	0.6	33.5	5.6
150	0	300	0.25	3.70	0.34	0.11	17	92a	26.9	0.0	31.1	5.4
Significance			NS	NS	NS	NS	NS	*	NS	NS	NS	NS
BLSD (.05)								20				

Table 7. Continued

Treatments lbs/A			%				ppm					
			P	K	Ca	Mg	Al	Fe	Zn	Cu	Mn	B
N	P_2O_5	K_2O										
						Third Cutting - July 21						
0	0	0	0.33b	2.84	0.56	0.26	41	126	29.0	7.9	22.2	5.4
150	50	300	0.35b	3.73	0.58	0.25	67	163	35.3	7.8	36.8	7.0
150	100	300	0.35b	3.89	0.58	0.26	58	151	32.3	6.1	34.3	6.0
150	150	300	0.43c	3.67	0.57	0.27	58	141	28.5	6.0	31.1	5.7
150	200	300	0.46c	3.73	0.65	0.30	62	146	33.5	6.5	35.9	7.1
150	0	300	0.27a	4.20	0.52	0.22	59	142	35.9	8.6	27.0	6.0
Significance			**	NS	NS	NS	NS	NS	NS	NS	NS	NS
BLSD (.05)			0.05									
						Fourth Cutting - Sept 3						
0	0	0	0.21ab	2.66	0.81	0.23	155bc	282	23.1	4.7ab	34.2	11.6
150	50	300	0.24ab	3.10	0.82	0.23	166c	292	22.1	2.4a	32.7	13.2
150	100	300	0.29b	3.21	0.75	0.21	130ab	250	20.0	3.7a	29.7	11.8
150	150	300	0.30bc	3.17	0.75	0.23	121a	252	20.0	3.5a	28.2	12.7
150	200	300	0.39c	2.82	0.81	0.28	126a	277	21.5	3.9a	33.8	13.5
150	0	300	0.19a	3.23	0.70	0.19	128a	262	25.8	5.9b	27.1	12.8
Significance			*	NS	NS	NS	*	NS	NS	*	NS	NS
BLSD (.05)			0.09				25			1.5		

+ Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

Table 8. Phosphorus removal by grassland under pasture management for various dates of harvest and phosphorus fertilizer treatments. Gully, Minnesota - 1974.

Treatments lbs/A			Phosphorus Removal lbs/A				
N	P_2O_5	K_2O	May 29	June 19	July 21	Sept 3	Total
0	0	0	1.5a+	3.5a	4.3a	2.4	11.7a
150	50	300	3.1b	5.1ab	8.2b	2.3	18.7b
150	100	300	4.8c	5.1ab	7.8b	2.5	20.2b
150	150	300	5.3cd	6.5b	10.8c	2.7	25.3c
150	200	300	6.5d	6.9d	4.4c	3.3	23.1c
150	0	300	1.9ab	3.1a	4.4a	1.4	10.8a
Significance			**	*	**	NS	**
BLSD (.05)			1.4	2.2	1.9		3.1

+ Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

Table 9. The effect of various rates of applied phosphorus on soil phosphorus concentrations. Gully, Minnesota - 1974.

Phosphorus Treatments	Soil depth - inches					
	0-1	1-2	2-3	3-6	6-9	9-12
lbs/A	ppm					
0	4	3	3	3	3	3
50	6	5	4	3	3	3
100	9	6	4	4	3	3
150	16	11	7	4	3	3
200	24	15	8	6	4	3

POTASSIUM TRIAL

Seven potassium treatments arranged in a randomized complete block design were replicated four times. The potassium trial was conducted under the same conditions as previously outlined. Base nitrogen treatments were applied as described for the phosphorus trial. Potassium and phosphorus were surface broadcast on April 17.

Potassium in addition to nitrogen and phosphorus applications produced no consistent increases in dry matter in 1974 (Table 10). This is somewhat surprising since soil test levels in the top 3 inches of the soil profile were very low at 98 pp2m. An adequate potassium supply with such a low test is substantiated by plant tissue analysis (Table 11), where potassium levels remained at or near the 3 percent level.

Total potassium uptake ranged from 98 to 303 lbs. of potassium per acre (Table 12). Potassium uptake with only nitrogen and phosphorus applications increased by 79 pounds over the check. It would appear that additions of nitrogen and phosphorus greatly stimulated potassium uptake.

Soil samples were taken on October 24 to determine the alteration in potassium concentrations in the soil profile due to the addition of potassium fertilizer. The results, Table 13, would indicate that potassium, like phosphorus, remained primarily in the upper 3 inches of the soil profile.

Table 10. Dry matter yields for grassland under pasture and hay management for various dates of harvest and potassium fertilizer treatments. Gully, Minnesota - 1974.

Treatments lbs/A			Grass Production - lbs dry matter/acre				
			pasture				
N	P_2O_5	K_2O	May 29	June 19	July 21	Sept 3	Total
0	0	0	553a+	719a	970a	868	3110a
150	100	0	1333b	1327b	2241b	1108	6009b
150	100	75	1620c	1431b	2452b	1083	6585bc
150	100	150	1538bc	1738c	2476b	1182	6934c
150	100	225	1215b	1470bc	2299b	1133	6117b
150	100	300	1387bc	1457b	2304b	1050	6198b
150	100	450	1477bc	1517bc	2673b	1207	6873c
Significance			**	**	**	NS	**
BLSD (.05)			272	270	324		629
			hay				
0	0	0		1757a		3269a	5026a
150	100	0		2925b		4163b	7089b
150	100	75		2974b		4423b	7397b
150	100	150		3053b		4231b	7285b
150	100	225		2725b		4593b	7318b
150	100	300		3038b		4344b	7382b
150	100	450		3216b		4728b	7944b
Significance				**		**	**
BLSD (.05)				738		581	1034

+ Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

Table 11. Plant analysis for grassland under pasture management for various dates of harvest and potassium fertilizer treatments. Gully, Minnesota - 1974.

Treatments lbs/A			%				ppm					
N	P_2O_5	K_2O	P	K	Ca	Mg	Al	Fe	Zn	Cu	Mn	B
						First Cutting - May 29						
0	0	0	0.40a+	3.22a	0.41bc	0.15ab	26	113	31.8	1.7	32.6	4.8bc
150	100	0	0.65b	2.96a	0.46c	0.17b	15	104	33.7	1.7	36.4	5.2c
150	100	75	0.58b	3.58b	0.41bc	0.15ab	11	99	32.9	0.8	35.2	4.8bc
150	100	150	0.58b	3.95bc	0.37ab	0.15ab	14	103	32.2	0.7	35.6	4.4ab
150	100	225	0.63b	4.09c	0.36ab	0.13a	6	109	33.7	1.7	39.5	4.8bc
150	100	300	0.59b	4.06c	0.37ab	0.13a	19	100	33.5	1.5	34.9	4.5b
150	100	450	0.63b	4.14c	0.33a	0.13a	4	96	33.3	0.8	40.2	4.0a
Significance			**	**	**	**	NS	NS	NS	NS	NS	**
BLSD (.05)			0.09	0.47	0.06	0.02						0.4
						Second Cutting - June 19						
0	0	0	0.32a	3.12a	0.36	0.14a	17	99	25.8a	1.6	33.1	5.0
150	100	0	0.53b	3.14a	0.47	0.20b	21	104	27.7a	1.9	47.3	5.8
150	100	75	0.52b	3.71ab	0.40	0.17b	25	107	32.4b	1.0	41.9	5.8
150	100	150	0.52b	4.20b	0.37	0.14a	20	104	26.2a	0.0	35.5	5.4
150	100	225	0.53b	4.18b	0.39	0.14a	22	100	26.7a	0.6	39.9	5.1
150	100	300	0.52b	4.18b	0.40	0.14a	29	107	26.2a	1.1	39.2	5.0
150	100	450	0.50b	4.22b	0.39	0.14a	24	108	28.5a	0.7	50.0	5.0
Significance			**	*	NS	**	NS	NS	*	NS	NS	NS
BLSD (.05)			0.08	0.65		0.03			3.1			

Table 11. Continued.

Treatments lbs/A			%				ppm					
N	P_2O_5	K_2O	P	K	Ca	Mg	Al	Fe	Zn	Cu	Mn	B
						Third Cutting - July 21						
0	0	0	0.32	3.44	0.58	0.28ab	53	139	31.2	8.3	26.6a	5.6
150	100	0	0.38	2.94	0.56	0.35b	53	137	32.7	8.5	31.9ab	6.1
150	100	75	0.48	3.88	0.57	0.26a	58	150	33.8	6.2	42.8bc	5.9
150	100	150	0.47	4.07	0.53	0.26a	64	152	32.9	5.7	43.6bc	6.4
150	100	225	0.45	3.93	0.51	0.21a	61	151	30.2	6.8	38.0b	4.7
150	100	300	0.43	4.04	0.48	0.23a	56	143	28.8	8.7	38.4b	5.6
150	100	450	0.43	4.38	0.99	0.21a	60	144	35.9	6.3	53.8c	4.6
Significance			NS	NS	NS	*	NS	NS	NS	NS	*	NS
BLSD (.05)						0.07					13.8	
						Fourth Cutting - Sept 3						
0	0	0	0.20a	2.83	0.67	0.22	98	211	22.8	6.0d	25.9	10.8
150	100	0	0.30b	2.86	0.69	0.28	90	227	19.4	4.1bc	30.1	11.6
150	100	75	0.31b	2.81	0.63	0.21	89	193	18.9	3.3ab	31.5	10.3
150	100	150	0.33b	3.45	0.55	0.20	81	203	18.1	2.8a	30.0	10.9
150	100	225	0.32b	3.64	0.61	0.20	103	220	19.4	4.6c	31.9	10.7
150	100	300	0.32b	3.25	0.57	0.19	102	216	17.9	4.7c	27.0	9.2
150	100	450	0.31b	3.27	0.58	0.19	84	210	19.0	4.0bc	38.0	10.7
Significance			*	NS	NS	NS	NS	NS	NS	*	NS	NS
BLSD (.05)			0.05							1.1		

+ Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

Table 12. Potassium removal by grassland under pasture management for various dates of harvest and potassium fertilizer treatments. Gully, Minnesota - 1974.

Treatments lbs/A			Potassium Removal lbs/A				
N	P_2O_5	K_2O	May 29	June 19	July 21	Sept 3	Total
0	0	0	18a	21a	34a	25	98a
150	100	0	40b	40b	67ab	30	177c
150	100	75	60c	60c	102bc	31	253c
150	100	150	61c	66c	114c	38	279c
150	100	225	50bc	65c	97bc	42	254bc
150	100	300	56c	64c	97bc	34	251bc
150	100	450	61c	72c	133c	37	303c
Significance			**	**	**	NS	**
BLSD (.05)			14	18	39		81

+Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

Table 13. The effect of various rates of applied potassium on soil potassium concentrations. Gully, Minnesota - 1974.

Potassium Treatments	Soil Depth - Inches					
	0-1	1-2	2-3	3-6	6-9	9-12
lbs/A	----------pp2m----------					
0	150	90	36	10	10	10
150	200	110	70	50	10	10
300	240	160	90	60	20	10

CONCLUSIONS

1. In 1974, 100 lbs. N/A applied in split applications, along with 50 lbs. P_2O_5/A gave optimum dry matter yields under hay management (2 cuttings).

2. Optimum dry matter yields under pasture management (4 cuttings) were obtained with additions of 150 lbs. N/A in split applications and broadcast applications of 100 lbs. P_2O_5/A.

3. No consistent yield responses to the application of potassium in addition to nitrogen and phosphorus were noted.

4. Soil tests indicated that applied phosphorus and potassium remained in the top 3 inches of the soil profile.

FERTILIZATION OF GRASS PASTURES

Crookston, Minnesota - 1974

R.P. Schoper, C. Simkins, J. Lensing

Minnesota has more than 2 million acres of unimproved grasslands. It includes areas of open, treeless grasslands, as well as areas of grass-woodland bush which are used primarily for grazing. Although much of this land is grazed each year from May to October, little of this land has been improved through fertilization.

As a follow-up to trials presented in last year's report[1] an experiment was established on a Rocksbury soil located on the Crookston Cattle Co. near Crookston, Minnesota. The soil test levels for the area were as follows:

pH - 8.2
available phosphorus - 8 lbs/A
exchangeable potassium - 140 lbs/A

The primary forage species in the area included timothy, bluegrass, white clover and redtop.

Ten fertilizer treatments, arranged in a randomized complete block design were replicated four times. Each plot, 20 feet by 20 feet in size were split into two subplots 10 feet by 20 feet. One subplot was used to simulate pasture management (clipped at an average height of 8-10 inches) and the other hay management (cut at an average height of 24 inches).

In Table 1 the dry matter yields under both pasture and hay management are presented. Due to below average rainfall during midseason (2.32 inches below normal) potential yields were greatly reduced. These conditions allowed for only 3 cuttings under pasture management and only 1 cutting under hay management in 1974.

Protein levels for the nitrogen treatments are included in Table 2. Protein levels remained adequate for all cuttings and increased significantly with increases in nitrogen rates.

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[1] See "A Report on Field Research in Soils," Soil Series 91, March 1974.

Table 1. Dry matter yields of grassland for various dates of harvest and fertilizer treatments. Crookston, Minnesota - 1974.

Treatments lbs/A			Grass Production - lbs. dry matter/acre				
			pasture				hay
N	P_2O_5	K_2O	June 4	June 26	Sept. 25	Total	June 26
0	0	0	304a[+]	412a	302a	1018a	1469ab
0	60	0	486a	633cd	686c	1805c	2792d
0	0	60	324a	447ab	314a	1085a	1396a
0	60	60	551a	650d	733cd	1934c	2573cd
30	60	60	957b	675d	690c	2322d	3532e
*30	60	60	957b	727d	835d	2519d	4032e
*60	60	60	1303c	859e	972e	3134e	5542f
*90	60	60	1636d	899e	874d	3409ef	6178fg
*120	60	60	1842d	944e	862d	3648f	6272g
*120	0	0	406a	534bc	517b	1457b	2105bc
Significance			**	**	**	**	**
BLSD (.05)			257	107	144	335	675

[+] Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.

* Plots received an additional 30 lbs. N/A after the second cutting under pasture management.

Table 2. Protein levels for grassland for various dates of harvest and nitrogen fertilizer treatments. Crookston, Minnesota - 1974.

Treatments lbs/A			Percent Protein ----------pasture----------		
N	P_2O_5	K_2O	June 4	June 26	Sept. 25
0	0	0	14.9a+	13.8a	10.8a
30	60	60	14.0a	13.4a	14.0e
*30	60	60	13.8a	13.6a	12.5cd
*60	60	60	15.8b	14.7ab	12.5cd
*90	60	60	18.3c	16.0b	12.4bc
*120	60	60	20.4d	17.8c	11.5ab
*120	0	0	21.1d	18.5c	13.3de
Significance			**	**	**
BLSD (.05)			1.3	1.5	0.9

+ Any letter(s) different from another letter in a column indicates a significant difference between means at the 5% level.
* Plots received an additional 30 lbs N/A following the second cutting.

CONCLUSIONS

1. The application of nitrogen without any additional applications of phosphorus and potassium resulted in only small increases in dry matter production.
2. The application of phosphorus alone produced significant increases in dry matter yield.
3. Nitrogen in combination with phosphorus and potassium resulted in the highest dry matter increases, especially on the first cutting.
4. Yields under hay management (1 cutting) out-weighed yields under pasture management (3 cuttings) by a ratio of 1.5 to 1.0.

EFFECT OF INOCULATING SOYBEANS WITH *RHIZOBIUM JAPONICUM*

G.E. Ham, Associate Professor

Rhizobium japonicum strains 110 and 138 were prepared commercially as normal humus inoculants, granular-based-humus inoculants and vermiculite base inoculants. Inoculum was applied as the normal seed inoculant and inoculum rates of 250, 500 and 1000 times the normal seed rate was applied in the furrow with the seed (all were hand planted from coin envelopes to avoid contamination). The soils contained rhizobia from previous soybean crops and the uninoculated controls were well nodulated. Seed yields were not increased significantly in any case (Table 1). The seed yields of the nodulating and nonnodulating isolines of Chippewa background were 38.4 and 26.8 bu/acre, respectively at Waseca and 29.4 and 22.7 bu/acre, respectively at Morris. The 11.6 and 6.7 bu. yield advantage of the nodulating isoline compared to the nonnodulating isoline indicate the yield responses that should be obtained if nodulation failures were present. The rhizobia in the soil from previous soybean crops are adequate since no yield increase can be demonstrated.

Table 1. Influence of inoculating soybeans with *Rhizobium japonicum* at Morris and Waseca.

Location	Inoculum* Treatment	Rhizobia Strain	Inoculant Type: Granular	Powder	Vermiculite
			bu/acre		
Morris	Control		35.2		
	Seed	110	31.7	34.1	35.2
	250X	110	36.7	34.6	34.1
	500X	110	35.3	33.7	35.3
	1000X	110	36.1	35.1	34.4
	Seed	138	35.2	37.6	36.1
	250X	138	33.8	34.9	37.3
	500X	138	34.7	35.0	35.3
	1000X	138	34.1	36.0	36.1
Waseca	Control		44.74		
	Seed	110	44.9	45.4	45.8
	250X	110	45.0	41.2	40.7
	500X	110	44.3	39.6	45.8
	1000X	110	44.4	42.5	44.7
	Seed	138	45.8	45.4	46.7
	250X	138	39.4	40.4	43.2
	500X	138	43.2	41.1	40.9
	1000X	138	42.2	43.2	40.6

*Inoculated at 250, 500, and 1000 times the normal seed inoculation.

SOYBEAN NITROGEN FERTILIZER STUDIES

G.E. Ham, S.D. Evans, G.W. Randall and L.J. Smith

Ammonium nitrate and urea were compared at Morris and Waseca at the rate of 50 and 100 pounds N per acre when applied in the fall and spring. In addition, urea at the rate of 200 pounds N was applied in the fall. Fall applied N was plowed-down and spring applied N was applied to the surface and disked-in before planting. Clay, Evans and Hodgson varieties were planted at Morris on May 6 and Corsoy, Hodgson and Wells varieties were planted at Waseca on May 3. Seed yields are shown in Table 1.

At Crookston urea was applied as a broadcast treatment in the spring before planting at the rate of 50, 100 and 200 pounds N per acre to Ada, Norman and Wilken variety soybeans.

Seed yields were increased at all locations with all varieties except Hodgson at Morris which was severely damaged by an early frost on September 3.

Table 1. Effect of nitrogen fertilizer on soybean seed yield at Morris and Waseca.

Location	Fertilizer treatment	Soybean Variety		
		Corsoy	Hodgson	Wells
	lbs. N/acre	----------bu/acre---------		
Waseca	Control	31.1	36.3	28.5*
	50 urea, fall	31.8	35.5	33.3
	50 urea, spring	32.8	37.9	31.0
	100 urea, fall	33.2	42.0*	32.4*
	100 urea, spring	32.2	37.4	31.5
	200 urea, fall	33.1	41.8*	32.8*
	50 amm. nitrate, fall	33.2	35.8	31.7
	50 amm. nitrate, spring	32.7	33.0	31.3
	100 amm. nitrate, fall	34.6*	34.4	31.8
	100 amm. nitrate, spring	32.5	40.6*	32.7*

Table 1 (continued):

Location	Fertilizer treatment	Clay	Evans	Hodgson
Morris	Control	28.9	32.6	28.6
	50 urea, fall	33.0*	33.1	26.7
	50 urea, spring	29.6	33.4	26.8
	100 urea, fall	33.1*	34.8	29.8
	100 urea, spring	33.3*	35.9*	29.4
	200 urea, fall	34.8*	35.2	30.8
	50 amm. nitrate, fall	33.1*	33.3	29.0
	50 amm. nitrate, spring	33.5*	33.0	29.4
	100 amm. nitrate, fall	33.6*	34.6	31.2
	100 amm. nitrate, spring	32.2*	36.8*	30.6

* Seed yield is significantly greater than the control yield for the same variety.

Table 2. Effect of nitrogen fertilizer on soybean seed yield at Crookston.

Nitrogen fertilizer	Soybean Variety		
	Ada	Norman	Wilken
lbs/acre	---------bu/acre----------		
0	24.0	24.2	28.8
50	24.8	27.2	33.9*
100	24.9	26.3	32.5*
200	27.2*	28.8*	26.4

* Seed yield is significantly greater than the control yield for the same variety.

FERTILITY OF PADDY SOILS AND FERTILIZATION OF WILD RICE

A PROGRESS REPORT
January 10, 1975

John Grava and Kenneth F. Rose
Department of Soil Science
University of Minnesota

Wild rice production in cultivated paddies is an important enterprise in several counties of northern Minnesota. Wild rice is our newest crop that is now undergoing domestication. While, so far, no major soil fertility problems have been encountered, there is need for better understanding of chemical and physical changes occurring in paddy soils. Furthermore, nutritional requirements of the plant need to be determined. Growers have raised questions concerning fertilizer rates, time of application, effectiveness of different N fertilizers. Efficient and proper use of chemical fertilizers is extremely important not only because of concern for energy conservation but also from the standpoint of environmental quality.

During 1974, a major effort was made to study the importance of N rate, time of application and plant density. These studies were conducted at Grand Rapids. Two fertilizer trials were conducted in Aitkin county to study effectiveness of K applications in disease control. Plant development was followed during the growing season in several growers' paddies.

A. FERTILIZATION EXPERIMENTS AT GRAND RAPIDS

Three experiments were conducted on mineral soil at the North Central Experiment Station, Grand Rapids. The experimental paddy was constructed in spring 1973 and then was seeded to oats. Soil tests were as follows: pH 6.1, 72 lb/A extr. P (VH), 280 lb/A exch. K (VH), texture: silty clay loam, 15 lb/A NO_3-N (0-6"). Fertilizer treatments (prior to seeding) were made on October 24 with a Gandy fertilizer spreader. Fertilizer was incorporated into soil by rototilling. Urea (46-0-0) was used as the N source and 0-46-0 and 0-0-60 supplied the P and K. Individual plots were 6 Ft. wide and 16 Ft. long. Plots were separated by 3-foot wide alleys. A late maturing (Johnson) variety of wild rice was seeded by hand on May 7, 1974. Seed then was rototilled into the soil. Water level in paddy was maintained at about 12 to 14 inches. Severe leaf burn resulted, prior to jointing, from a malathion application to control midge. Plants, however, recovered from it rather quickly. Three applications of malathion were made to control rice worm. For yield determinations, a 4 X 4 foot square area from each plot was hand-harvested on September 16 and 17.

Below normal temperatures during August and September affected the filling of grain. (The frost on Labor Day weekend did not kill plants). Consequently, significant yield differences from fertilizer treatments were obtained only in a few cases.

Temperature of paddy soils may affect the biological and chemical activities that are so important in determining nutrient availability and plant growth. Soil temperature in the paddy at Grand Rapids varied considerably during the growing season (Fig. 1). In early May, the temperature ranged from 40 to 50° F. The soil warmed up rapidly and by the first of June the temperature ranged from 65 to 75° F. The temperature peaked during the three first weeks of July. During that time, maximum temperature of 80 to 85° F was recorded. During August soil temperature fluctuated from low 70's to high 60's. In September, just before harvest, temperature ranged from 63 to 55° F.

Redox potential (Eh) of flooded paddy soil was determined by placing platinum electrodes into the root zone. Readings of Eh ranged from -272 to -315 indicating a strongly reduced condition in the mineral soil.

Nitrogen rate and time of application (Exp. II)

Four rates of N (0, 40, 80, 120 lb/A) and four application times (fall, Oct. 24; early tillering, 7/3; jointing, 7/19; early flowering, 7/30) were compared in an experiment conducted at Grand Rapids. Treatments, arranged in randomized blocks, were replicated four times.

Urea (46-0-0) was applied with a 3-foot Gandy spreader on Oct. 24 and incorporated into soil by rototilling. Additional N was topdressed by hand at 3 different stages of plant development. Phosphorus and potassium were not applied because soil tests had indicated high availability of these nutrient elements. Plant population in this experiment was 5 plants per square foot.

Grain yields (5% moisture) ranged from 622 to 828 lb/Acre (Table 1). Forty pounds of N per acre applied prior to seeding produced the highest yield. There was no advantage of using the 80 lb/Acre rate, and the 120 pound rate of N, in some instances, decreased grain yield. Single applications of N, made prior to seeding, were equal or slightly superior to the split applications.

Early applications of N increased plant height, measured about one week past jointing stage (Table 2).

In early stages of plant development, N treatments had no effect on plant weight (Table 3). However, already at jointing, dry matter production was increased by N treatments and was related to the rate applied. Over 35 grams of dry matter were produced by a single plant receiving 120 lb/Acre of N.

Total uptake of nitrogen, at jointing and early flowering, was related to N rates (Table 4). While the 40 lb/Acre rate of N increased the nitrogen uptake only slightly, it was twice as high with the 120 lb/Acre rate compared to no treatment. This would indicate that wild rice can obtain fertilizer N from mineral paddy soils quite readily.

Nitrogen treatments had little effect on tillering of plants (Table 5).

Nitrogen rate and plant density study (Exp. III)

Three N rates (40 lb/Acre fall; 80 lb/Acre - 1/2 in fall, 1/2 at jointing; 120 lb/Acre - 40 lb in fall, 80 lb at jointing), and four plant densities (1, 5, 10, 25 plants per square foot) were compared in an experiment at Grand Rapids. Twelve treatments were replicated three times. Average plant densities, determined at early tillering were as follows: 0.5, 5.0, 10.7, 22.3 plants per square foot.

Highest yields were obtained with 40 lb/Acre of N, and tended to decrease as the nitrogen rate increased. Plant density had some effect on the yield. Highest yields were obtained with 5 to 10 plants per square foot. Somewhat lower yields were produced with 25 plants per square foot.

Wild rice tillering was greatly affected by plant density (Table 7). While the low density plants had 12 tillers, less than 2 tillers per plant were found at the highest density. Wild rice from 5 and 10 plant density plots had 5 and 3 tillers, respectively. Nitrogen treatments, however, had no effect on number of tillers.

While plant weight decreased greatly from the lowest to the highest densities, it was not affected by N treatments (Table 8).

Lodging appeared to be more severe on high density plots receiving 120 lb/Acre N (Table 9).

NPK trial

Six fertilizer treatments, replicated twice, were used to study the needs of wild rice for the three major nutrient elements. Yields ranged from 597 to 837 lb/Acre. There was no response to P and K. This was not surprising since soil tests had indicated high availability. Nutrient concentrations in 2nd leaf at jointing also were high: 3.56-4.22% N, 0.58-0.70% P, 3.07-4.01% K.

Fig. 1

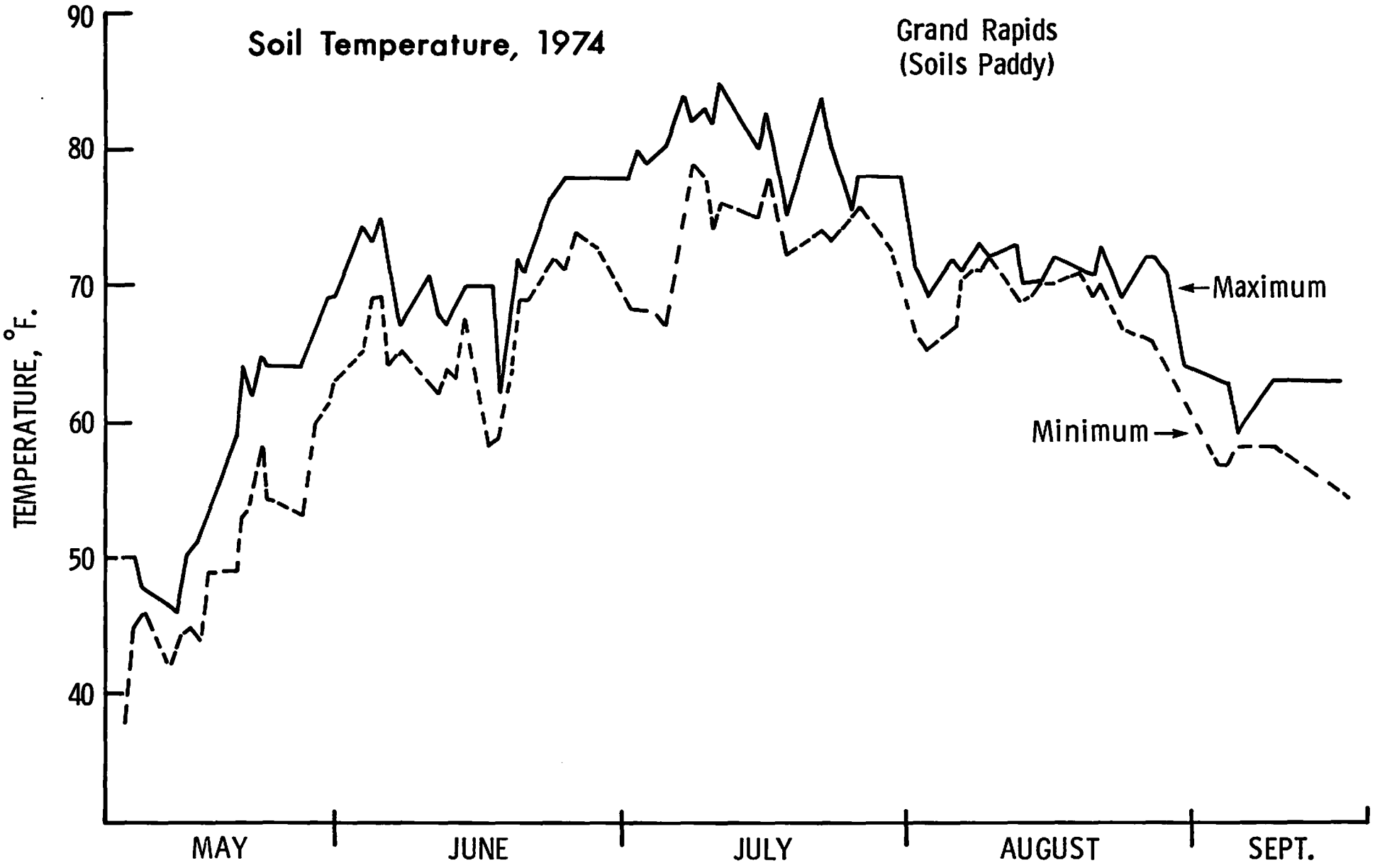
Soil Temperature, 1974
Grand Rapids
(Soils Paddy)
TEMPERATURE, °F.
90
80
70
60
50
40
Maximum
Minimum
MAY
JUNE
JULY
AUGUST
SEPT.

Table 1. Effect of nitrogen rate and time of application on wild rice yield.

Treat-ment No.	N rate lb/Acre	Time of application Oct. 24	July 3	July 19	July 30	Yield* lb/Acre
		N lb/Acre				
1.	0	-	-	-	-	731
4.	40	40	-	-	-	828
5.	80	80	-	-	-	782
6.	120	120	-	-	-	739
2.	40	-	-	40	-	768
3.	80	-	-	80	-	581
7.	80	40	40	-	-	780
8.	120	40	80	-	-	626
9.	80	40	-	40	-	789
10.	120	40	-	80	-	738
11.	80	40	-	-	40	796
12.	120	40	-	-	80	653

* 5% moisture; percentage grain recovery ranged from 48 to 58

Table 2. Effect of N application on the height of wild rice*

N rate lb/Acre	Plant height in centimeters
0	118**
40***	124
80***	135
120***	144
80****	132
120****	132
80+	115

* Measurements made on July 26.
** Average of 40 random plants.
*** Applied on Oct. 24.
**** 40 lb. applied on Oct. 24, 40 or 80 lb. on July 3.
\+ Applied at jointing, on July 19.

Table 3. Effect of N application on dry matter production of wild rice.

Date	Stage of development	N rate, lb/Acre*			
		0	40	80	120
		Dry matter, grams per plant			
6/20	Floating leaf	.06	.06	.06	.06
7/1	Aerial leaf	.34	.37	.33	.38
7/11	Tillering	2.01	1.98	1.38	2.29
7/19	Jointing	3.58	5.26	5.34	6.71
8/5	E. flowering	17.03	18.22	20.55	33.07
8/13	L. flowering	22.95	32.60	33.66	29.37
9/4	E. grain formation	27.18	28.92	28.77	35.57

* N was applied on Oct. 24.

Table 4. Effect of N application on nitrogen uptake by wild rice

Date	Stage of development	N rate, lb/Acre*			
		0	40	80	120
		N, milligrams per plant			
6/20	Floating leaf	2	2	3	3
7/1	Aerial leaf	12	4**	12	15
7/11	Tillering	71	78	55***	90
7/19	Jointing	108	154	161	221
8/5	E. flowering	304	331	429	697

* N was applied on Oct. 24.
** Due to low N concentration (1.07%);
*** Due to low dry matter weight.

Table 5. Effect of N application on tillering of wild rice

Treatment No.	Late tillering	Jointing	Early flowering	Flowering
	7/11	7/19	8/5	8/13
	Number of tillers per plant			
1.	2.5	2.8*	5.3	1.8
4.	3.0	3.2	4.0	3.3
5.	2.4	4.7	6.9	2.8
6.	3.1	5.3	6.5	2.0
2.	-**	-	6.3	-
3.	-	-	3.8	-
7.	-	-	5.0	-
8.	-	-	4.5	-
9.	-	-	4.6	-
10.	-	-	5.1	-
11.	-	-	-	-
12.	-	-	-	-

* Average of 12 plants; includes the main stem.
** Not determined.

Table 6. Effect of N rate and plant density on yield

		Number of plants per square foot				
		1	5	10	25	Ave.
		Grain yield*, lb/Acre				
N lb/Acre	40	674	669	714	355	603
	80	567	574	584	590	579
	120	499	701	656	379	559
	Ave.	580	648	651	441	

* 5% moisture; percentage grain recovery ranged from 44 to 55.

Table 7. Tillering as affected by plant density and N application

		Number of plants per square foot				
		1	5	10	25	Ave.
		Number of tillers per plant				
N	40	11.4*	4.9	2.5	1.6	5.1
lb/Acre	80	12.0	4.9	2.9	1.4	5.3
	120	12.7	4.9	3.2	1.7	5.6
	Ave.	12.0	4.9	2.9	1.6	

* Ave. of 10 plants, determined on 8/28.

Table 8. Plant weight as affected by plant density and N application

		Number of plants per square foot				
		1	5	10	25	Ave.
		Dry matter, grams per plant				
N	40	30.12	26.54	12.49	7.84	19.25
lb/Acre	80	35.46	24.96	18.29	7.50	21.55
	120	27.53	23.56	18.88	10.56	20.13
	Ave.	31.04	25.02	16.55	8.63	

Table 9. Effect of plant density and N application on lodging

		Number of plants per square foot				
		1	5	10	25	Ave.
		Lodging				
N	40	0.7	1.8	2.2	3.3	2.0
lb/Acre	80	0.5	1.7	2.0	2.5	1.7
	120	1.2	2.3	3.5	4.3	2.8
	Ave.	0.8	1.9	2.6	3.4	

Observations made on Sept. 4.
Rating of 1 = little lodging; rating of 5 = severe lodging.

B. EFFECTS OF NITROGEN AND POTASSIUM ON DISEASE

The role of potassium in wild rice production is subject to frequent inquiries. The possibility that losses by disease and lodging may be lessened, as in other crops, by K applications is most intriguing to growers. In 1973 at Palisade, the least diseased plants were found in plots receiving the 60+40+200 lb/Acre N, P_2O_5, K_2O treatment.

In 1974, two experiments were conducted on organic and mineral soils on paddies owned by Jacobson Bros., Aitkin county. Fertilizer materials were broadcast by hand on April 24 and rototilled into the soil.

Observations on severity of Helminthosporium blight were made on August 22 by R. E. Kroll, Plant Pathology Department. Defoliation (including all leaves) was evaluated according to Barratt-Horsfall rating system. Percentage of stems infected at the water line was calculated from the number of plants (of ten) that had a lesion at the water line but not more than 15 cm above the water line. The data are reported in tables 10 and 11.

The least diseased plants were found on plots receiving the heavy rate of potassium (200 lb/Acre K_2O), with one notable exception, and that is treatment No. 9 (120+40+200) on the peat paddy. This treatment had higher values for stem breakage, defoliation and lodging and somewhat lower yield.

On peat, plots receiving 200 lb/Acre K_2O combined with 0 and 40 lb/Acre N, showed less lodging than plots receiving the 0 or 40 lb/Acre K_2O rate (table 12). This, however, was not true for the 120+40+200 treatment.

On mineral soil, the lodging ratings ranged from 2 to 3 and were not related to fertilizer treatments.

Grain yields (5% moisture), on peat, ranged from 247 to 436 lb/Acre, but were not related to fertilizer treatments (table 13). Average plant population at harvest was 5.4 plants per square foot. (Number of tillers per plant at jointing ranged from 1 to 3). Nitrogen and potassium treatments had no effect on N and K concentration of 2nd leaf at jointing. Nitrogen ranged from 3.02 to 3.72% and potassium from 3.32 to 4.09%.

On mineral soil, grain yields were relatively low (71 to 214 lb/Acre) and inconsistent due to damage by blackbirds, disease and rice worm.

Table 10. Effect of NK applications on wild rice infection with Helminthosporium. Jacobson Bros., Aitkin Co., Peat-1974.

	Treatment N	P_2O_5 lb/Acre	K_2O	Overall defoliation %	Stems infected at water line %
1.	0 +	40 +	0	25*	40*
2.	0 +	40 +	40	19	46
3.	0 +	40 +	200	6	33
4.	40 +	40 +	0	22	46
5.	40 +	40 +	40	13	53
6.	40 +	40 +	200	6	36
7.	120 +	40 +	0	19	43
8.	120 +	40 +	40	9	30
9.	120 +	40 +	200	48	50

* Average of 3 replications

Table 11. Effect of NK applications on wild rice infection with Helminthosporium. Jacobson Bros., Aitkin Co., mineral soil-1974

	Treatment N	P_2O_5 lb/Acre	K_2O	Overall defoliation %	Stems infected at water line %
1.	0 +	40 +	0	28*	50*
2.	0 +	40 +	40	41	70
3.	0 +	40 +	200	28	40
4.	40 +	40 +	0	50	55
5.	40 +	40 +	40	28	53
6.	40 +	40 +	200	9	50
7.	120 +	40 +	0	63	65
8.	120 +	40 +	40	63	45
9.	120 +	40 +	200	9	35

* Average of 2 replications

Table 12. Effect of NK applications on wild rice lodging
Jacobson Bros., Aitkin Co. Peat-1974

	Treatment N		P_2O_5		K_2O	Lodging*
	lb/Acre					
1.	0	+	40	+	0	2.7**
2.	0	+	40	+	40	3.2
3.	0	+	40	+	200	1.3
4.	40	+	40	+	0	3.3
5.	40	+	40	+	40	2.5
6.	40	+	40	+	200	2.0
7.	120	+	40	+	0	1.8
8.	120	+	40	+	40	1.8
9.	120	+	40	+	200	4.0

* Rating of 1 = little lodging; rating of 5 = severe lodging; observations were made on 8/13, at late flowering.
** Average of 3 replications

Table 13. Effect of NK application on wild rice yield on peat-1974.
Jacobson Bros., Aitkin Co.

		N, lb/Acre			
		0	40	120	Ave.
	0	375*	327	417	373
K_2O	40	390	351	436	392
lb/Acre	200	398	416	247	354
	Ave.	388	365	367	

* Average of 3 replications; 5% moisture; average grain recovery 46%

C. CROP FAILURE AND PRESENCE OF SULFUR COMPOUNDS IN SOIL

High concentrations of sulfur compounds in soil apparently were responsible for stand decrease and dying out of plants in a commercial paddy at Gully used for fungicide spray experiments. By July 10, the stand had decreased in an area where strong hydrogen sulfide odor was detected. Most roots of affected plants had black segments.

Soil samples from two different areas were collected after crop harvest and analyzed (table 14). Soil, from the area where crop died out (site 2), had sulfate concentrations ranging from 165 to 1800 ppm S, low pH values in some horizons, and contained moderate amounts of soluble salts. Sulfate concentration in the upper 26 inches of soil from site 1 (crop: fair) was below 8 ppm S and did not exceed 90 ppm S in samples from lower horizons. Organic soils, high in sulfur compounds, appear to be unsuitable for wild rice production.

Table 14: Soil test values of two profiles of Cathro Muck, Gunvalson and Imle wild rice paddy, Pennington County.

Horizon	Depth, Inches	Type of Fiber	Texture	pH	O.M.	Extr. P pp2m	Exch. K pp2m	S ppm	Sol. Salts mmhos
			Site No. 2 where crop died out						
Oa1	0-11	Sap.	P	6.2	VH	29	120	165	2.7
Oe	11-21	Hemic	P	5.0	VH	5	50	185	2.2
Oa2	21-29	Sap.	P	5.3	VH	3	50	195	3.4
BA1	29-33	-	H SiCl	6.5	H	4	230	1800	3.0
C1	33-45	-	L	7.4	L	3	170	360	2.9
IIC2	45-62	-	Lvfs	7.7	L	5	80	234	2.6

Note: Upper 12 inches gave off a noticeable hydrogen sulfide odor.

			Site No. 1, Crop: fair						
Oa1	0-10	Sap.	P	6.8	VH	7	100	7	0.9
Oa2	10-19	Sap.	P	6.7	VH	3	40	3	0.6
Oa3	19-26	Sap.	P	6.3	VH	5	90	6	1.0
BA1	26-31	-	SiCl	7.3	H	3	250	84	1.1
C1	31-42	-	H Cl	7.9	L	4	150	81	1.0
C2	42-52	-	Cl	8.0	L	5	180	90	1.1

Note: Few fragments of iron pyrite in C2 horizon

Samples collected on Oct. 24, 1974 by Donald Barron and Rodney Heschke, Soil Conservation Service. Soil Tests by University of Minnesota Soil Testing Laboratory.

D. SURVEY OF GROWERS' PADDIES

Plant development was followed during the growing season in 6 growers' paddies. Plant samples were collected at seven development stages for determination of dry matter production and chemical composition. Since plant analyses have not been completed much of the data are incomplete.

Most meaningful information seems to be obtained from two 2nd year paddies on peat in Aitkin county (Kosbau Bros.). An early maturing (K-2) variety was grown. Both paddies received following amounts of plant nutrients: 10+40+60 fall
75+ 0+ 0 pre-boot (46-0-0)
Total 85+40+60.

Relatively high concentrations of plant nutrients were found in 2nd leaf at jointing stage (table 15).

Table 15. Yield, stand density and nutrient concentration of 2nd leaf at jointing stage - 1974.

Paddy	Yield* lb/Acre	Stand density, plants per square foot	N	P	K
			Percent in dry matter		
F3 (1)	711	4	4.02	.82	3.2
F2 (2)	922	8	3.70	.70	3.2

* 5% moisture; average grain recovery 50%

SUMMARY AND CONCLUSIONS

Two N rate, time of application and plant density experiments were conducted at Grand Rapids during 1974. Forty pounds of N per acre applied prior to seeding produced the highest yield. There was no advantage of using higher N rates or topdress applications. Total uptake of N by the plant was related to the rates used. This would indicate that wild rice can obtain fertilizer N from mineral paddy soils quite readily. Highest yields were obtained with plant densities of 5 or 10 plants per square foot. While low density plants produced 12 tillers each, less than 2 tillers per plant were found at the highest density. Nitrogen fertilization had little effect on tillering. Lodging appeared to be more severe on high density plots receiving 120 lb/Acre N.

Two experiments were conducted on commercial paddies in Aitkin county to study N and K effects on disease. The least diseased and lodged plants were found on plots receiving 200 lb/Acre of K_2O combined with 0 or 40 lb/Acre of N. These beneficial effects of high potassium rate were nullified on peat, however, by the application of 120 lb/Acre of nitrogen. Grain yields were not related to fertilizer treatments. Fertilization had no effect on N and K concentration of 2nd leaf at jointing stage.

Crop failure in a commercial paddy on peat at Gully, Minnesota occurred in areas where strong odor of hydrogen sulfide was detected in July. Sulfate concentrations in the soil profile samples from the affected area ranged from 165 to 1800 ppm S. Organic soils high in sulfur compounds appear to be unsuitable for wild rice production.

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SOIL TESTING

John Grava

Currently the University of Minnesota Soil Testing Laboratory processes over thirty five thousand samples annually. The following data show the number of various types of samples analyzed in 1974.

Regular Farm Samples		21,740
Lawn and Garden Samples		4,338
Florist (Greenhouse) Samples		2,258
Specials:	Nitrate	1,785
	Sulfur	1,461
	Zinc	851
	Soluble salts	792
	pH	398
	Organic matter	175
Limestone		35
Departmental Research Samples		1,248
	Total	35,081

Monthly distribution of regular farm, lawn and garden samples received by the laboratory is shown in Table 1.

Table 1. Monthly Distribution of Soil Samples Received by the University of Minnesota Soil Testing Laboratory During 1974.

Month	Number of Samples
January	550
February	411
March	965
April	3,454
May	2,810
June	840
July	1,356
August	1,992
September	3,071
October	4,963
November	3,571
December	2,095

FIELD EXPERIMENTS WITH SOIL MODIFICATION ON AN IRRIGATED SANDY SOIL - ELK RIVER - 1974

R.S. Farnham and Bob Schoper

Experiments with both organic and inorganic detention layers on an irrigated Hubbard coarse loamy sand soil at Elk River begun in 1969 were continued in 1974. The objectives of these studies were to modify the soils root-zone environment by placing detention layers at 18 inches to effect increased water and nutrient availability. Materials used in these layers to modify the root-zone included peats, wood products, composted garbage, calcined clay and vermiculite. The layers were installed both in rows and in 14 foot square plots.

Experimental Methods

Plots were fertilized with 300 pounds per acre of 8-10-30 which was broadcast and disked in on May 14th. Corn was planted May 15th in 36 inch rows at a population of 25,640 plants per acre. A band application of 217 pounds of 8-10-30 was also applied at planting. Variety of corn planted was Minhybrid 4201 (a 110 day maturity corn). Herbicide used at planting was atrazine and Lasso. An additional 170 pounds of nitrogen was applied during growing season as side dressings; June 11, June 30, and July 3rd. Approximately one inch of irrigation water was applied each week during the growing season. A total of 11 inches irrigation water was added in 1974. Corn was bit by frost on September 1 and again on the 3rd which resulted in a shorter than normal season and greatly reduced yields. Corn was harvested October 21st.

Results

Yields on these plots were much lower in 1974 than in the previous years due to the early frost. Yields in 1974 ranged from 100 to 120 bushels as compared to previous years' averages of 185 to 190 bushels per acre. The detention layers in many cases do appear to be contributing to higher corn yields. Differences in yield due to these layers do not appear to be as wide now as they were when the experiments were first started. The 1975 experiments with these detention layers will be the last year of this study.

Table 1. Field Corn Yields with Soil Modification - 1974.

A. Square Plots	Detention Layers - 1974 Yield bu/acre (15.5% H_2O)
Checks (No Detention Layers)	113
Sphagnum Peat	120
Reed-Sedge Peat	108
Hydromulch (Wood Product)	118
Calcined Clay	117
Vermiculite	120

B. Row Plots	Average Yield - (bu/acre)
Check	108
Hydromulch (Wood Product)	110
Composted Garbage	113
Reed-Sedge Peat (fresh)	108
Reed-Sedge Peat (composted)	112
Sphagnum Moss Peat	108
Vermiculite 1/2"	111
Vermiculite 3/4"	97
Vermiculite 1"	109
Calcined Clay	97